Hydrogeology of the Thousand Springs to Malad Reach of the Enhanced Snake Plain Aquifer Model

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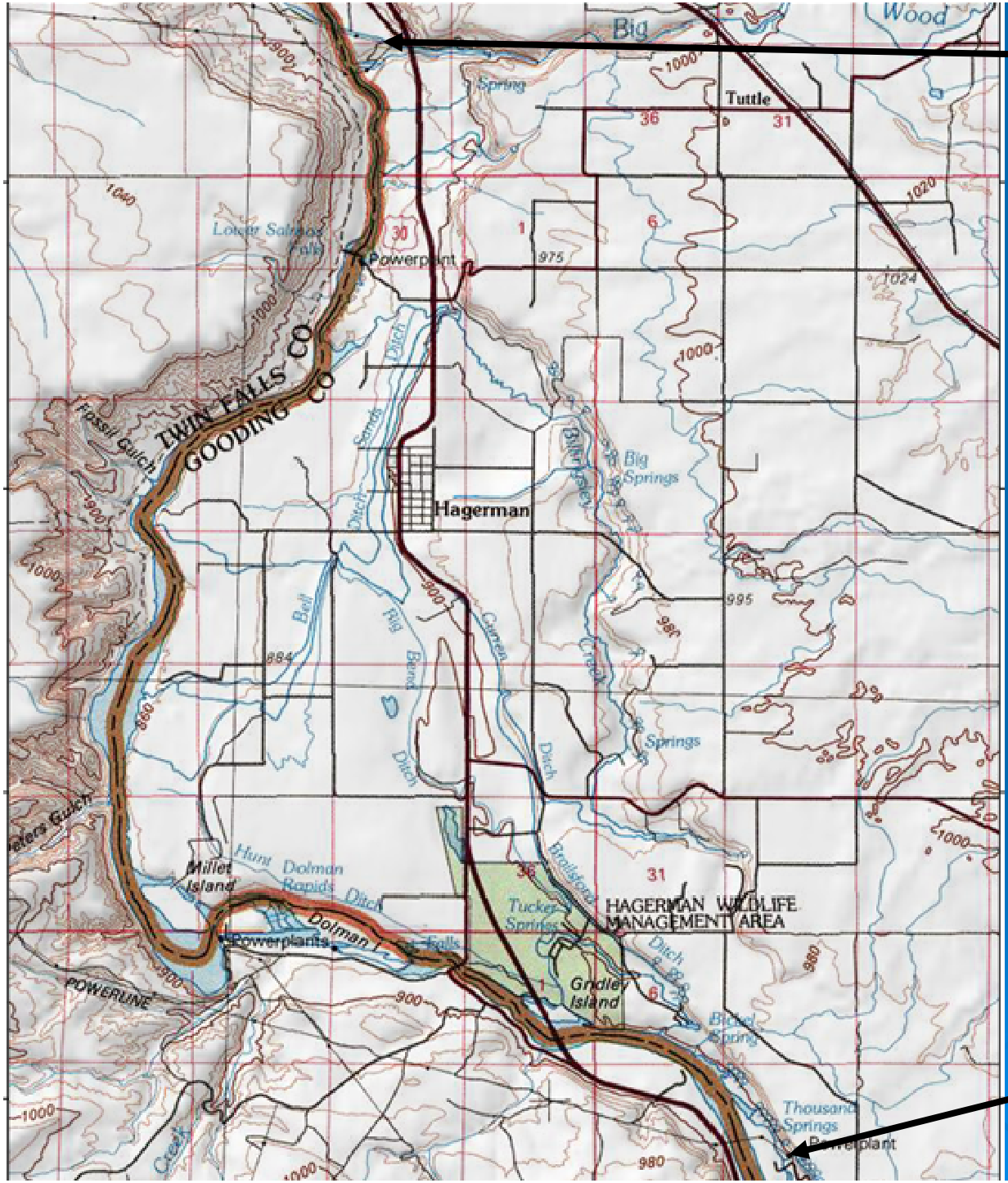
Objectives

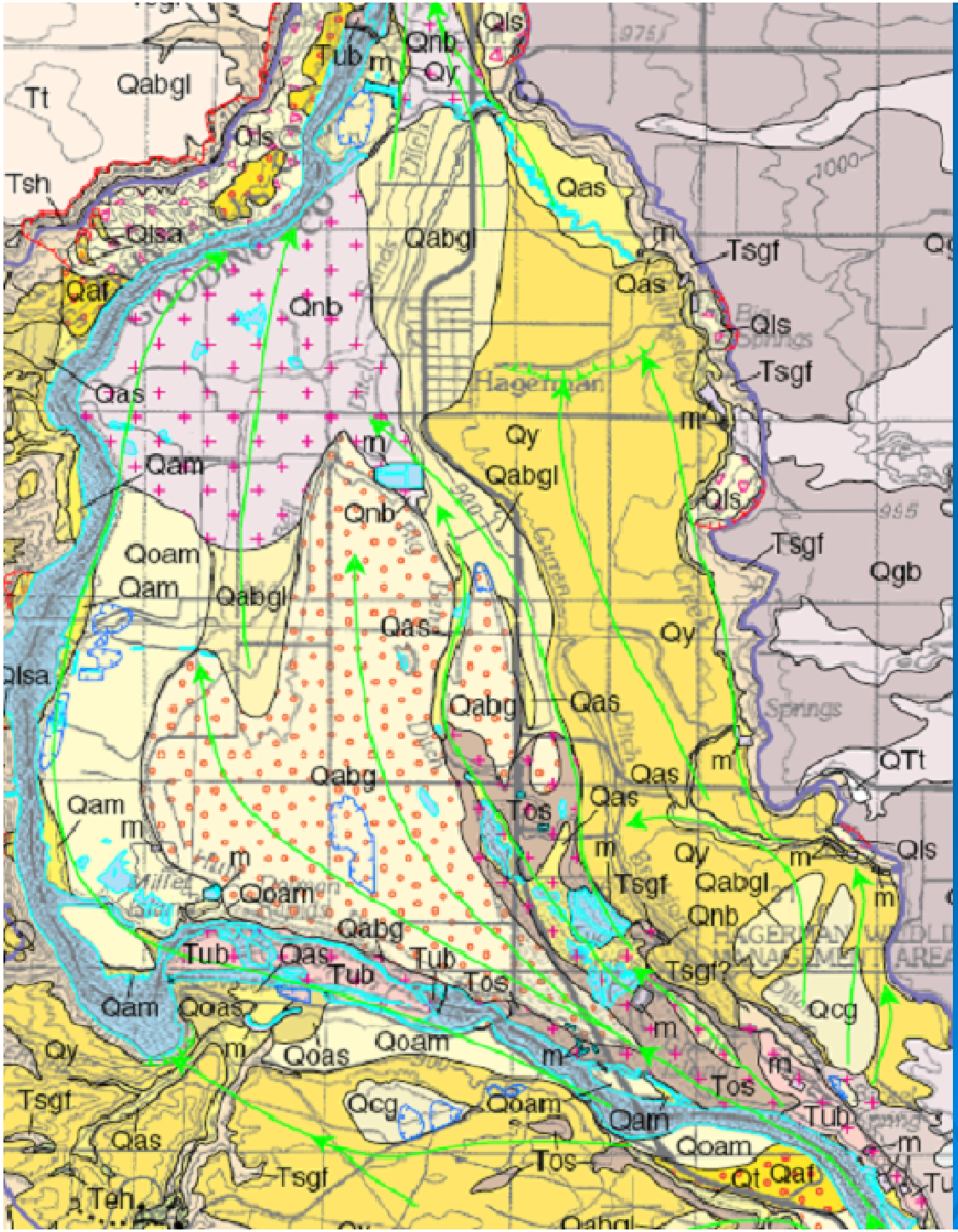
- Describe the hydrogeologic setting of the Thousand Springs to Malad reach of the Snake River
- Describe how the model represents the hydrogeology of this area
- Provide recommendations relative to changes of the model to better represent the field conditions



Location Map for the Thousand Springs to Malad Reach of the Snake River

Geologic Setting -- 1

- Quaternary basalt units outcrop mostly on the Plateau east of the Snake River; outcrop areas of Quaternary basalt are present west and south of Hagerman
- Tertiary sedimentary and basalt units outcrop between the Plateau rim and the Snake River



Geologic Map

Quaternary Basalt Units

- Qnb – Basalt of Notch Butte
- Qbby – Basalt of Bacon Butte, younger unit
- Qbbo – Basalt of Bacon Butte, older unit
- Qftb – Basalt of Flat Top Butte
- Qgb – Basalt of Gooding Butte

Quaternary Sedimentary Units

- Qam, Qoam, Qas and Qoas – Alluvium units
- Qls – Landslide units
- Qabf and Qabg – fine-grained and coarse-grained flood deposits
- Qy – Yahoo Clay

Tertiary Sedimentary and Basalt Units

- Tt – Tuana Gravels
- Tsgl – Glenns Ferry Formation
- Tos – Basalt of Oster Lakes
- Tub – Older Tertiary Basalt Flows

Geologic Setting -- 2

- Tertiary Glenns Ferry Formation (Tsgf) underlies the Quaternary basalt units over most of the Plateau
- Tertiary basalt flows (Tub) outcrop in the Thousand Springs area and are believed to underlie the Quaternary basalt in this area

Geologic Setting -- 3

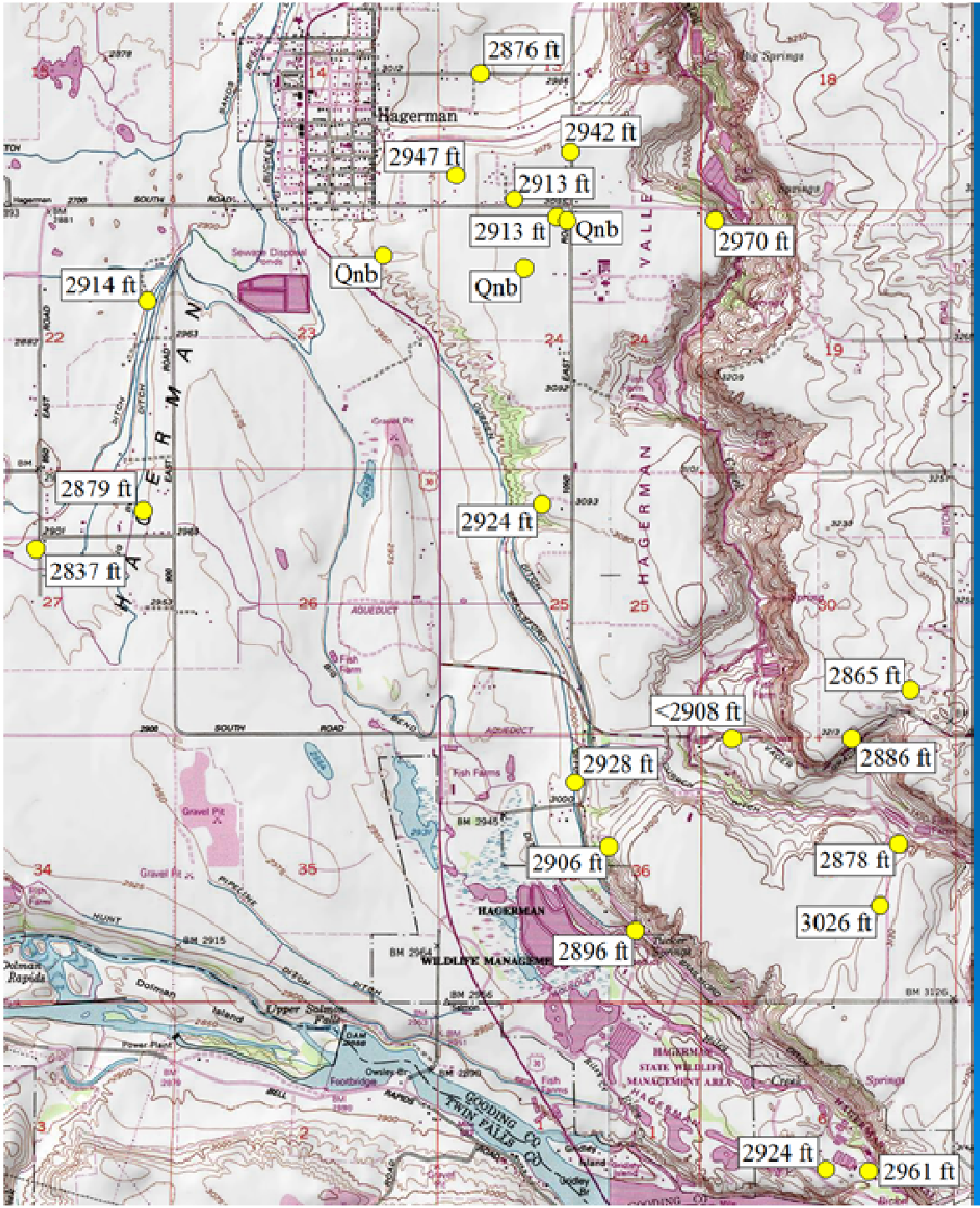
- Dr. Kurt Othberg of the Idaho Geological Survey has postulated that the contact between the Quaternary and Tertiary units generally dips to the east-northeast from the plateau rim in the Thousand Springs to Malad area.
- His theory is based on the large-scale structural setting of this portion of the Snake Plain where the center of the basin has been down dropped relative to the margins of the basin.

Hydrogeologic Setting -- 1

- Snake Plain aquifer in the Thousand Springs to Malad reach occurs primarily within the Quaternary basalt
- The bottom of the aquifer likely is the contact between the Quaternary basalt units and the underlying Tertiary sedimentary and/or basalt units

Hydrogeologic Setting -- 2

- Almost all of the springs within the Thousand Springs to Malad reach are located along the contact between the Quaternary basalt units and the underlying Tertiary sedimentary and/or basalt units
- The elevation of the top of the Tertiary basalt and the elevation of the bottom of the Quaternary basalt provide important information relative to the hydrogeologic setting of the area

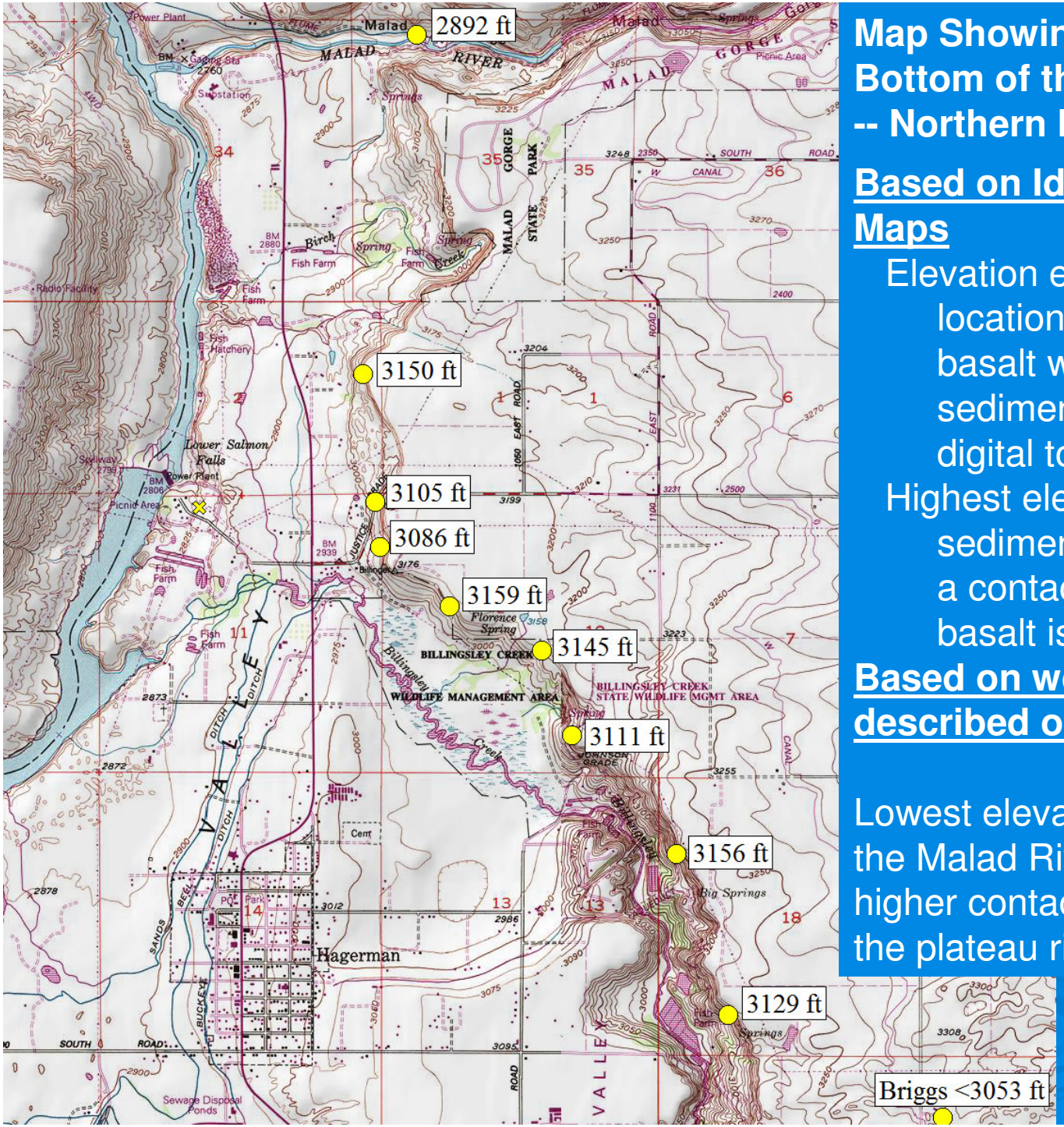


Map Showing the Elevation of the Top of the Tertiary Basalt

Based on well driller reports

- GPS locations with elevations from digital topo maps
- Subsurface contacts based on well location relative to surface geology and on material descriptions
- Quaternary basalt described as having frequent layering of black and red basalt with fracture zones
- Tertiary basalt described as more uniform with fewer red or fracture zones
- Accuracy of subsurface contact elevations is estimated to be about +/- 30 feet

Mostly in range of 2,870 to 3,000 feet



Map Showing the Elevation of the Bottom of the Quaternary Basalt -- Northern Half

Based on Idaho Geological Survey Maps

- Elevation estimated based on location of contact of Quaternary basalt with underlying Tertiary sediment and/or basalt on a digital topographic map
- Highest elevation of Tertiary sediment and/or basalt when a contact with the Quaternary basalt is not shown

Based on well driller reports as described on the previous slide

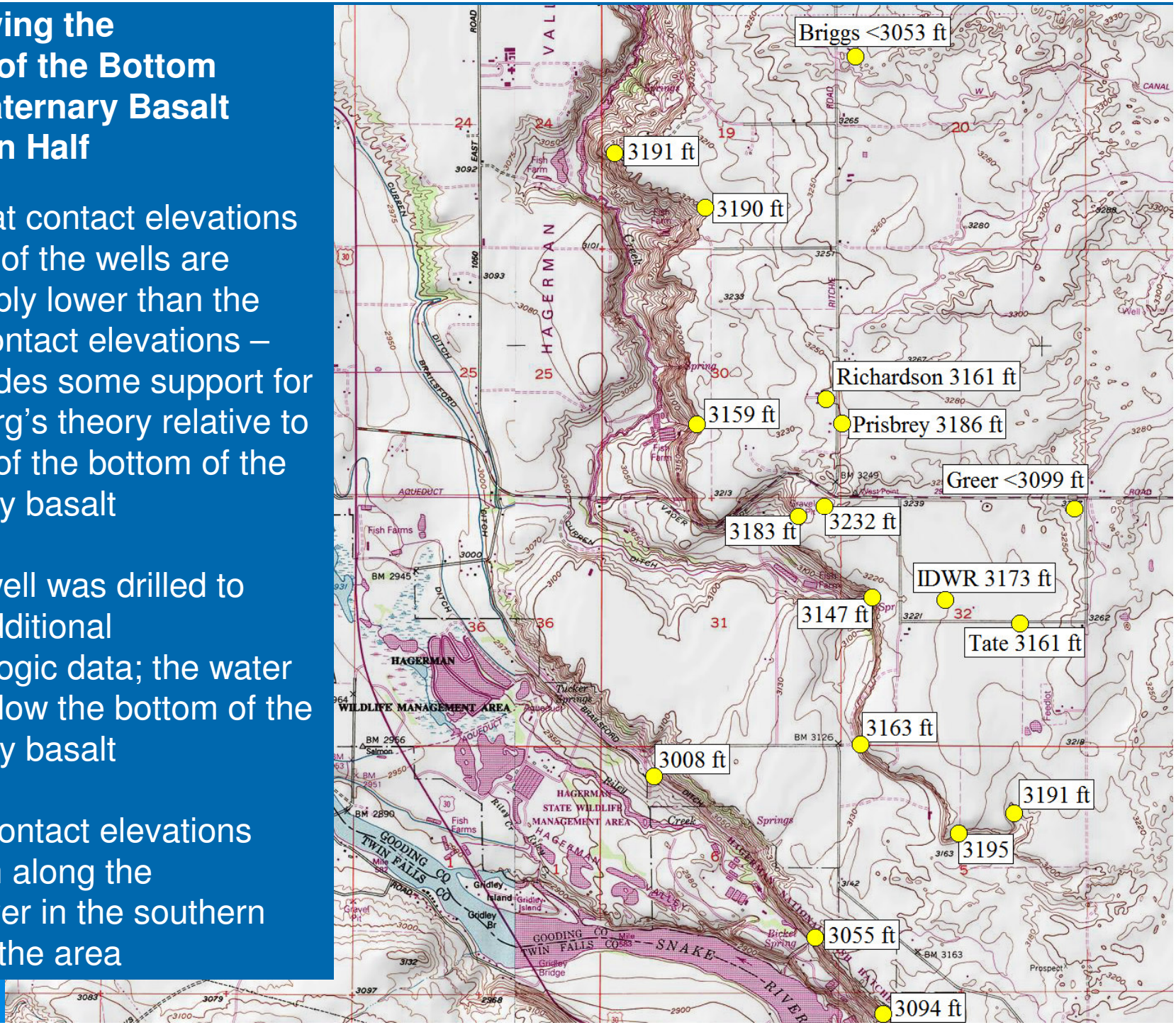
Lowest elevation shown is along the Malad River (2,892 feet) with higher contact elevations along the plateau rim

Map Showing the Elevation of the Bottom of the Quaternary Basalt -- Southern Half

-- Note that contact elevations in several of the wells are considerably lower than the outcrop contact elevations – This provides some support for Dr. Othberg's theory relative to the slope of the bottom of the Quaternary basalt

-- IDWR well was drilled to provide additional hydrogeologic data; the water level is below the bottom of the Quaternary basalt

-- Lower contact elevations are shown along the Snake River in the southern portion of the area



Hydrogeologic Summary -- 1

- Topography of the geologic contact between the Quaternary basalt units and the underlying Tertiary sedimentary and/or basalt units along the plateau rim is an important controlling factor for ground-water flow and spring discharge characteristics in the Thousand Springs to Malad Reach

Hydrogeologic Summary -- 2

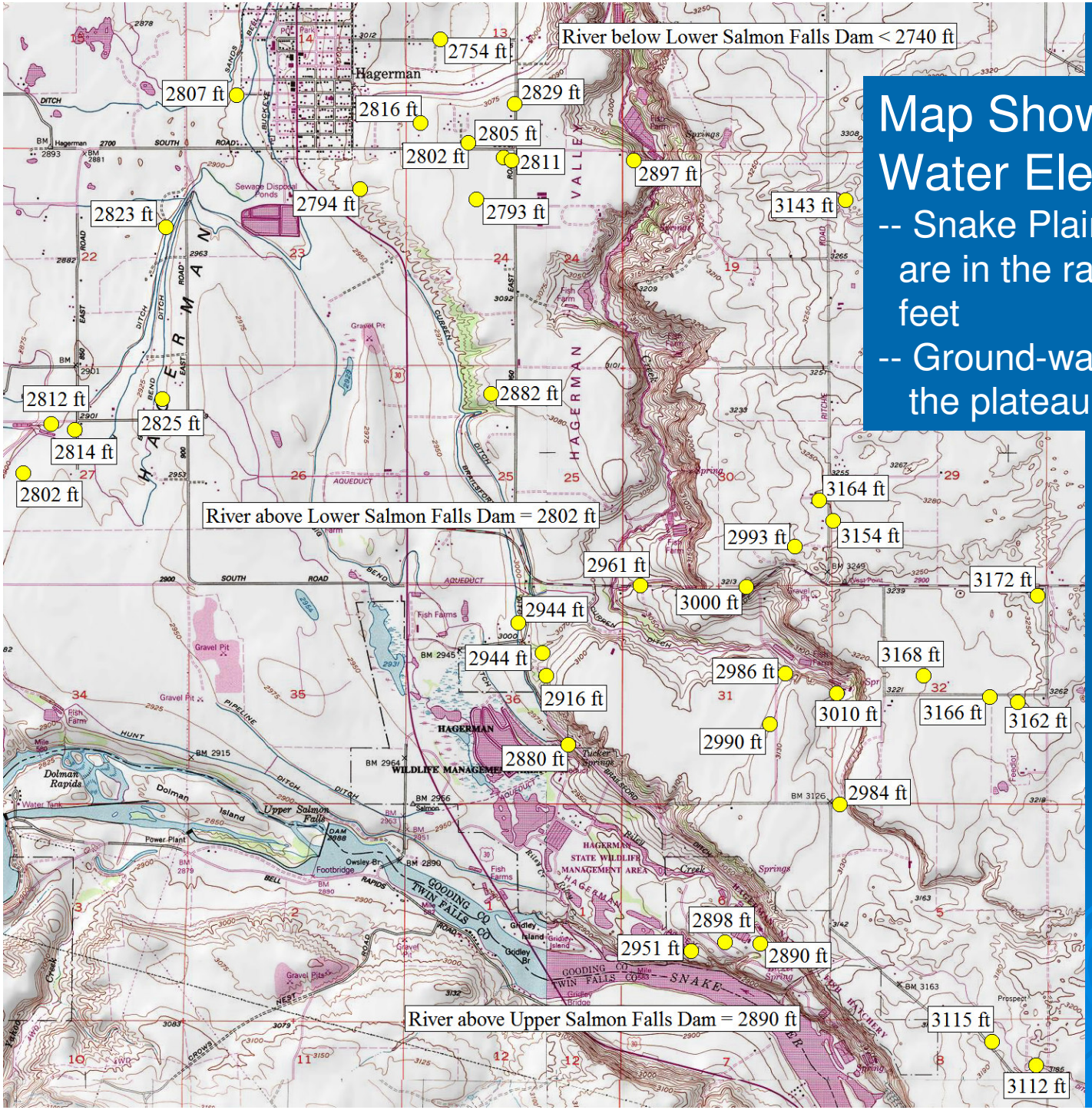
- Areas where the elevation of the geologic contact is low in comparison to the elevation of the regional water table in the aquifer have higher transmissivity and logically greater and more constant spring discharge.

Hydrogeologic Summary -- 3

- The geologic contact is present at a lower elevation in the Thousand Springs area (3,055 to 3,094 feet) and the Malad area (2,893 feet) than in the intervening reach 3,080 to 3,190 feet)
- The discharge from the Thousand Springs area and from the Malad area are both greater than from the intervening reach

Ground-Water Elevation Data

- Ground-water elevation values were determined from well driller reports
- Sources of uncertainty include
  - Land elevation (based on GPS locations)
  - Accuracy of depth-to-water measurements taken by drillers
  - Water-level measurements taken at different times of the year and in different years.



Map Showing Ground-Water Elevations in Wells

-- Snake Plain aquifer elevations are in the range of 3,100 to 3,200 feet

-- Ground-water elevations west of the plateau are 200+ feet lower

Water-Level Elevation Summary

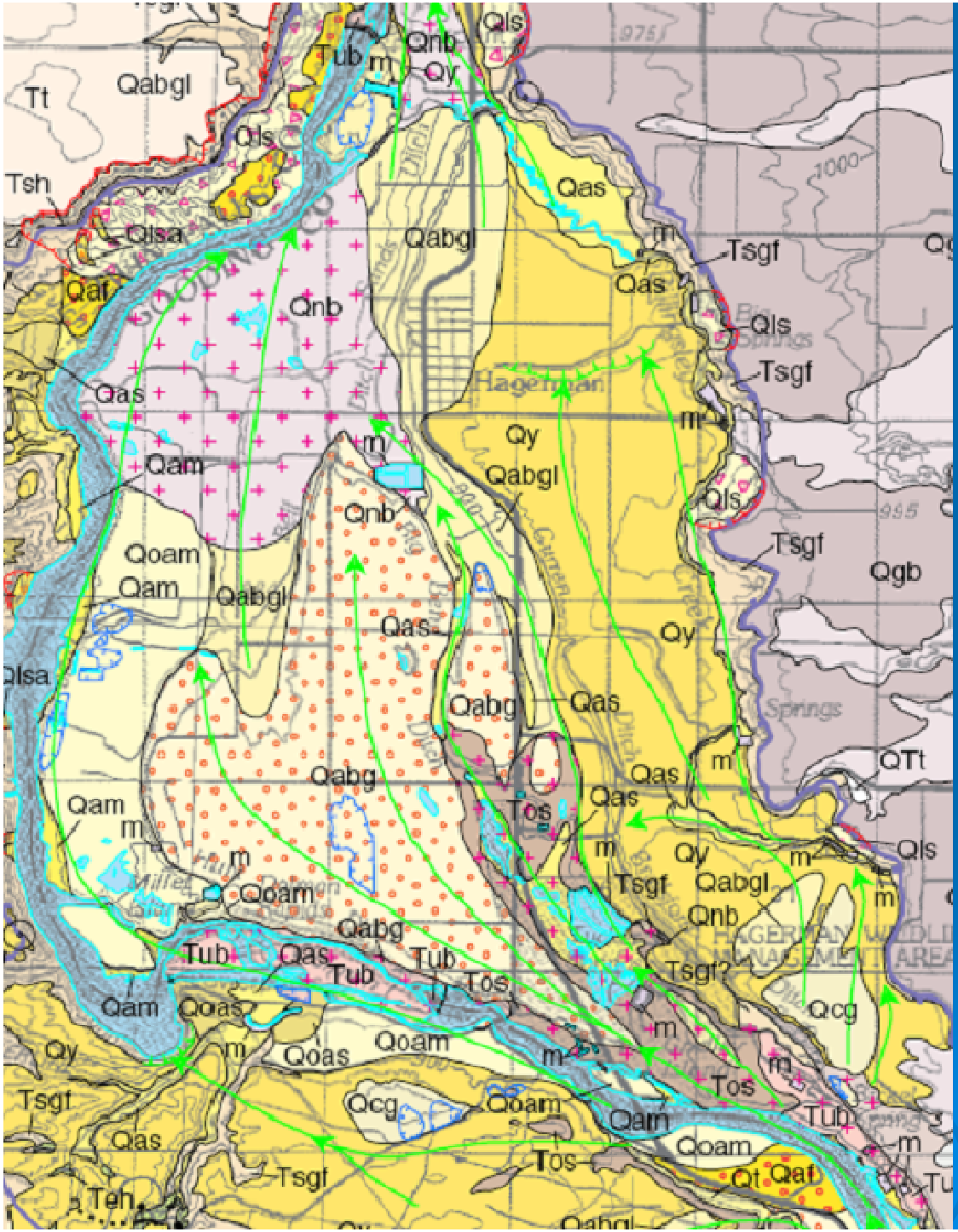
- Wells that are not completed in the Snake Plain aquifer (most are located between the plateau rim and the Snake River) have water-level elevations as much as 400 feet lower than the Snake Plain aquifer
- Water-level data from wells for the northern two-thirds of the area between the plateau rim and the river are similar to river elevation and may show a hydraulic connection with the river

Question #1 Relative to Hydrogeologic Controls for Springs

- Does the nature of the contact between the Quaternary basalt units and the underlying Tertiary sedimentary and/or basalt units provide the primary control for springs emanating from the Snake Plain Aquifer in the Thousand Springs to Malad Reach?
- Answer: **Yes.**

Question #2 Relative to Hydrogeologic Controls for Springs

- Does the postulated dip of the contact between the Quaternary and Tertiary units in combination with the location of the Snake and Malad Rivers provide an explanation for the relatively small combined discharge from springs in the Thousand Springs to Malad reach relative to the Thousand Springs area and the Malad area?



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Question #2 Relative to Hydrogeologic Controls for Springs

- Answer: **Insufficient information is available at this time to support or refute this hypothesis. If such a dip is present, the Thousand Springs area, located in an eastward portion of the Snake River, would be down dip and have a lower base elevation for the Quaternary basalt. The large springs along the Malad River likely are related to erosion of the canyon.**

Question #3 Relative to Hydrogeologic Controls for Springs

- Is the Snake Plain aquifer, as represented in the ESPAM, contained only within the Quaternary basalt units that are located on the plateau?
- Answer: Yes. Wells completed in the Quaternary basalt units that are present west of the plateau rim have much lower water-level elevations than the aquifer.

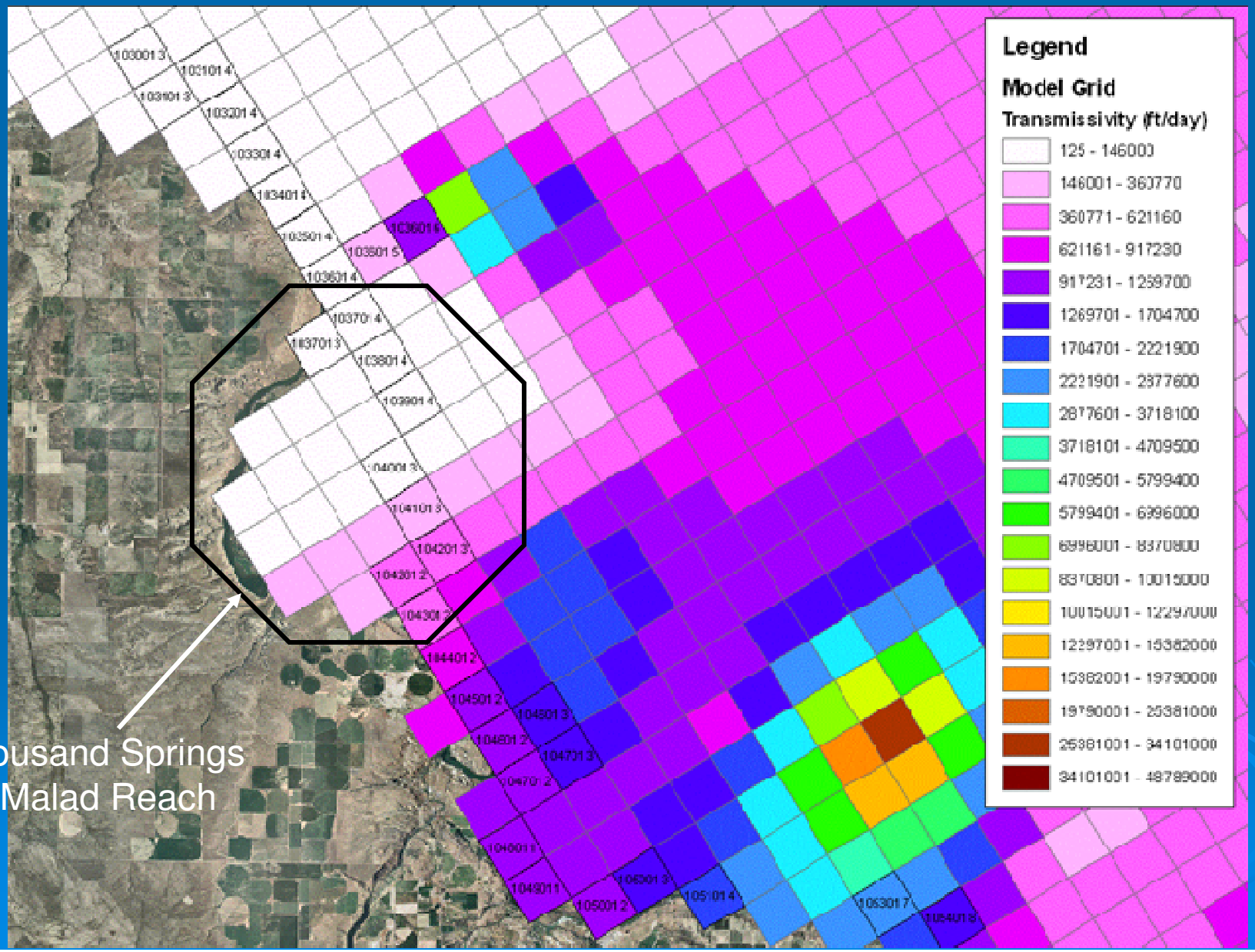
Two questions are important relative to representation of the Thousand Springs to Malad reach in the ESPAM

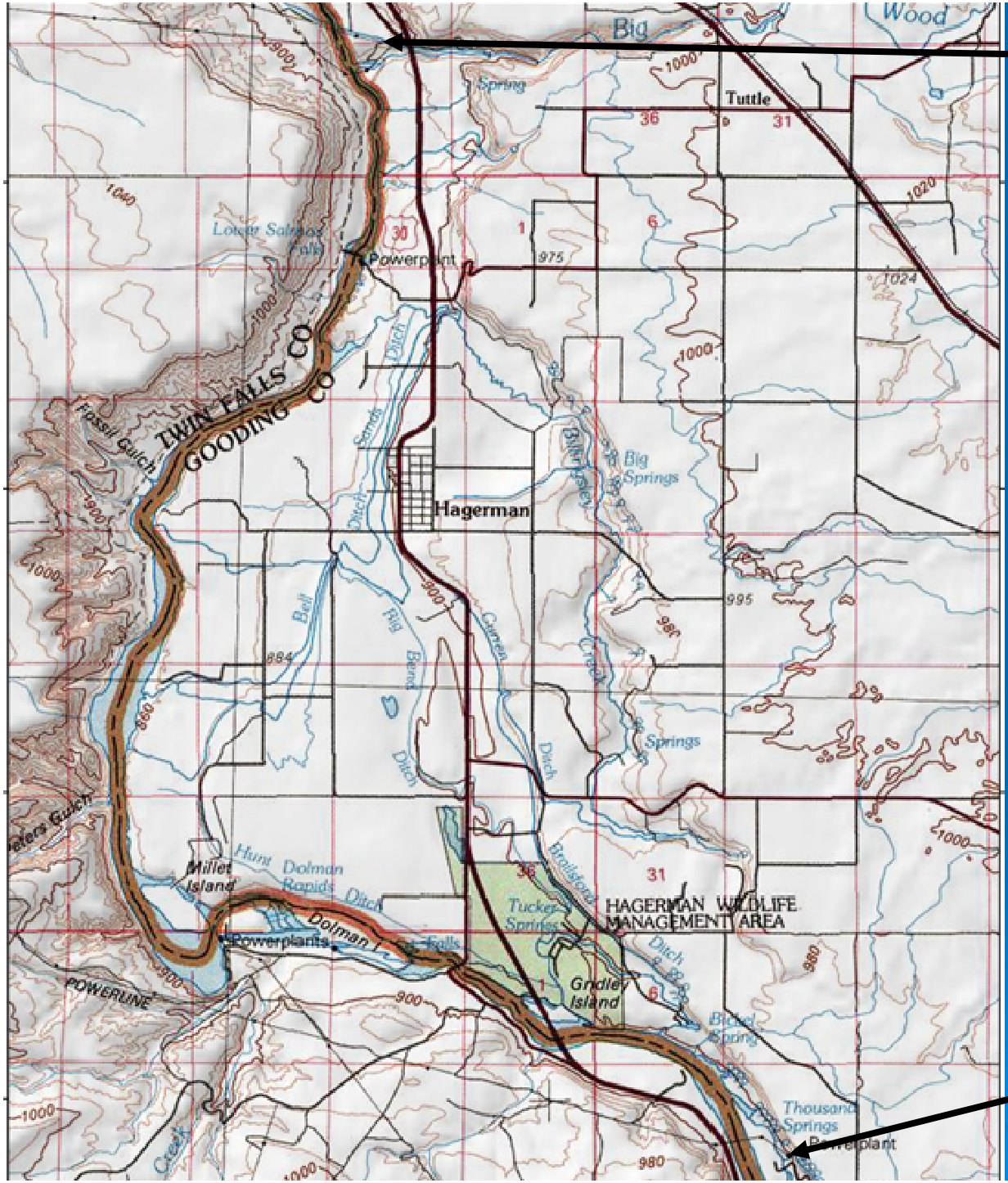
- Is representation of the springs in the reach using the Drain Package reasonable?
- Is the transmissivity array used to represent this portion of the model reasonable?

Drain conductance and node transmissivity values, in general, are lower for the Thousand Springs to Malad reach than the Thousand Springs or Malad to Bancroft reaches. The bold number are used to identify sites where the drain elevation was lowered to keep the nodes from going dry.

Row	Column	Drain Elevation (ft)	Drain Conductance (ft^2/day)	Transmissivity (ft^2/day)	Reach
45	12	3,075	404,081	1,043,000	Thousand Springs
44	12	3,059	15,649,154	854,090	Thousand Springs
43	12	3,050	500,578	600,610	Thousand Springs
42	**12**	**3,072**	29,734	366,120	Thousand Springs
42	**13**	**3,096**	24,060	442,630	Thousand Springs to Malad
41	**13**	**3,098**	2,168	212,840	Thousand Springs to Malad
40	**13**	**3,095**	944	107,990	Thousand Springs to Malad
39	**14**	**3,074**	33,836	50,859	Thousand Springs to Malad
38	14	3,072	949	42,024	Thousand Springs to Malad
37	14	3,047	11,480	53,376	Thousand Springs to Malad
37	13	3,058	34,838	49,094	Thousand Springs to Malad
36	14	3,016	9,501	69,683	Thousand Springs to Malad
36	16	3,072	11,183	163,220	Malad to Bancroft
36	**15**	**2,999**	1,158,866	961,770	Malad to Bancroft

Model calibrated transmissivity values are shown below





Location Map for the Thousand Springs to Malad Reach of the Snake River

Conclusions relative to Model Representation of Site Hydrogeology

- 1. The ESPAM includes the general Hagerman area between the plateau rim and the Snake River in the Thousand Springs to Malad reach. This area should be excluded from the model because the Snake Plain aquifer is not present in this area.

Conclusions Relative to Model Representation of Site Hydrogeology

- 2. The transmissivity of the Snake Plain aquifer likely is very low along the plateau rim in the Thousand Springs to Malad reach because the saturated thickness is small (difference between the water level and the bottom of the Quaternary basalt). The model representation of transmissivity reasonably fits with this hydrogeologic conceptual model.

Conclusions Relative to Model Representation of Site Hydrogeology

- 3. The elevations of drains used for the Thousand Springs to Malad reach are lower (up to about 100 feet) than the estimated elevation of the bottom of the Quaternary basalt along the plateau rim. In part, this was done on purpose to insure that the drain nodes would not go dry. The model representation of the springs using drains reasonably fits with the hydrogeologic conceptual model.

Thank you!